THE IMPACT OF ESTABLISHING INTERNET EXCHANGE POINTS

ITU REGIONAL SEMINAR ON COSTS AND TARIFFS FOR MEMBER COUNTRIES OF THE REGIONAL GROUP FOR AFRICA

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Agenda

- Interconnection Analogy
- Overview of Africa's Interconnection Infrastructure
- Addressing Africa's Internet Transit deficit
- The Impact of IXPs in Africa
- Conclusion

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As communication is essential for trade, an increase in trade also increases the demand for communication. For the same reason, improving telecommunications infrastructure and reducing costs leads to higher growth in trading than in non-trading sectors. Dr. Bruckner *(ITU/ESCAP/WTO Joint Seminar on Telecommunication and Trade Issues Bangkok, 28-30 October 2003)*

Interconnection Analogy:

Airports and IXPs

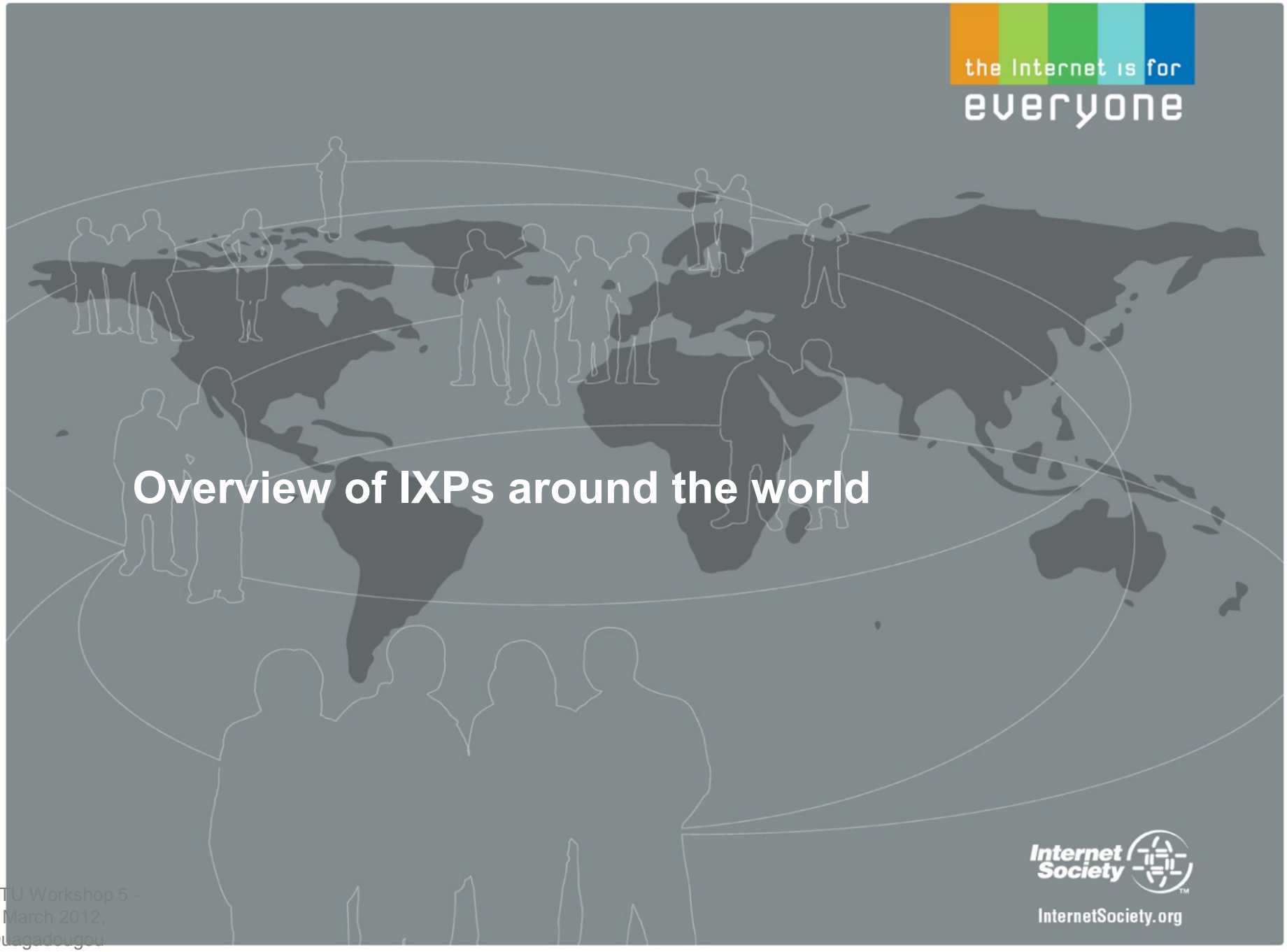
- Objective of airports is offer an efficient transit point for passengers – Similar to IXPs
- Airlines are traffic driven similar to Internet carriers/operators.
- Destinations for both Airlines and Internet Carriers are predetermined based on the locations value proposition and potential traffic volume
- Most importantly the facility's ability to attract more carriers and efficiently handle the traffic
- Facility features and services are value added services

Airport Example: DXB

Growth in traffic at Dubai International Airport[59][60]

Airlines	1986	1990	1994	1998	2002	2006	2010
Passenger movements	3.775 million	4.347 million	6.299 million	9.732 million	15.973 million	28.788 million	47.181 million
Airfreight movements (tonnes)	99,338	144,282	243,092	431,777	764,193	1.410 million	2.270 million
City links	19	36	54	110	170	195	210
Weekly scheduled flights	N/A	N/A	N/A	2,350	2,850	4,550	6100
Airlines	N/A	N/A	N/A	80	102	113	135

- The 4th busiest by International passenger traffic and 14th busiest by overall passenger traffic.
- 6th Busiest by cargo traffic as of 2012
- In 2010 DXB handled over 47.2Million passengers.
- Plans are underway to extend the airport to handle 80million passengers by 2012 and 90 million by 2018.
- Shopping, real-estate and regional financial hub status in addition to ease of connecting eastbound and westbound attract passenger traffic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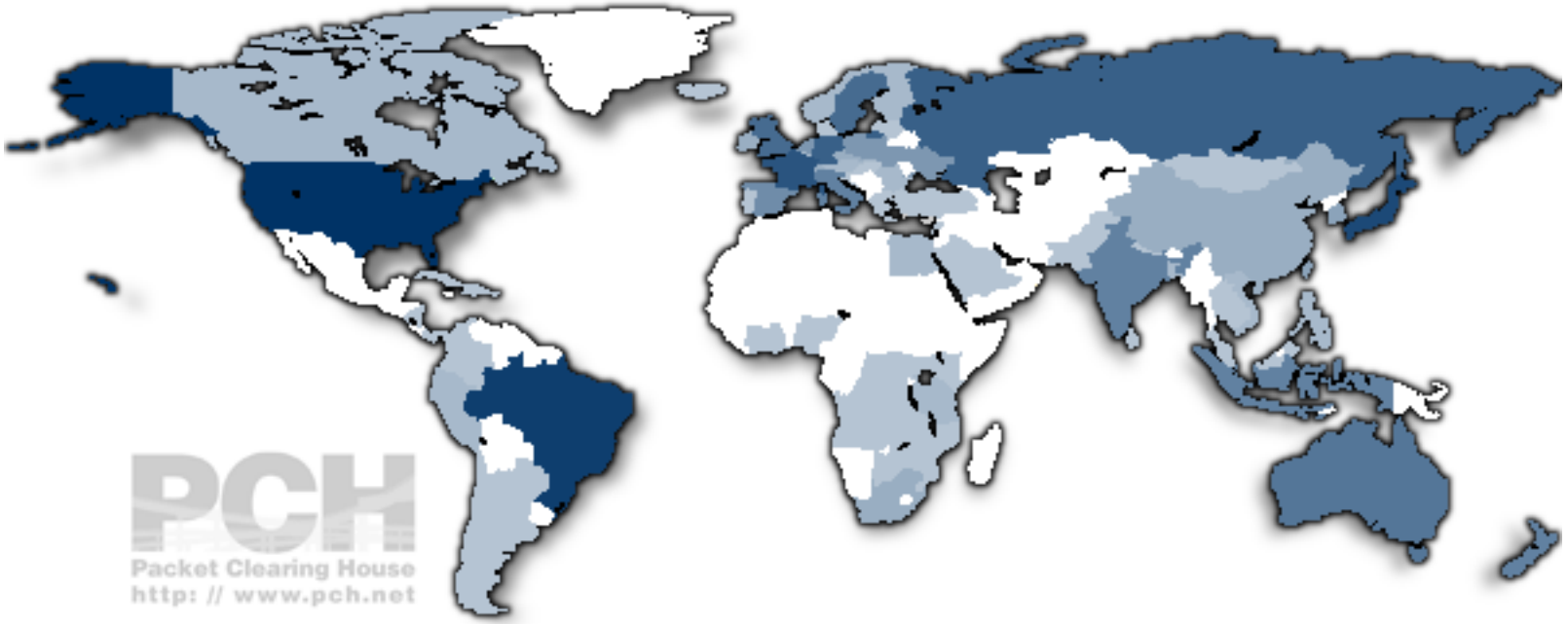
IXP density around the world



- 91 countries with IXPs
- 107 countries without IXPs
- America, Brazil and Europe have the highest density of IXPs
- North, West Africa and Middle East are regions with least IXPs

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IXP Growth Per Region

Region	Internet Exchange Points				Domestic Bandwidth Production			
	Feb 2011	Feb 2012	Net Change	Percent Change	Feb 2011	Feb 2012	Net Change	Percent Change
Africa	21	21			3.23G	5.19G	+1.97G	+61%
Asia-Pacific	76	76			1.14T	1.3T	+157G	+14%
Europe	138	138			6.2T	8.63T	+2.44T	+39%
Latin America	34	34			61.8G	108G	+46.2G	+75%
North America	88	89	+1	+1%	877G	982G	+105G	+12%
Total	**357**	**358**	**+1**		**8.28T**	**11T**	**+2.75T**	**+25%**

- Latin America recorded the highest percentage growth
- European has the highest number of IXPs and aggregate traffic
- Asia-Pacific exchanges more traffic than N.A despite having less IXPs
- Africa 2nd in % growth with lowest number of IXPs and traffic exchanged

Summary of North America IXP

- Due to the history of the Internet and the US the first IXP's known as Federal Internet Exchanges (FIX) East and West were built in 1989 under the NSFNET
- Soon after the first Commercial Internet Exchange (CIX) was built on the West Coast.
- In 1990 the 1st commercial IXP Metropolitan Area East (MAE) on the East Cost (Wash. DC)
- Thereafter the NSFNET awarded contracts for the running of 4 Network Access Points (NAPs)
- Over the years traffic reduced from the NAPs to Private Interconnections
- There 89 IXPs in the US today most of which are ***commercially operated.***
- Most of there IXPs are owned and operated by Data-Center companies

Summary of Latin America & Caribbean IXPs

- The LAC region is as diverse as the Asia-Pacific region.
- The IXPs are commonly referred to as Network Access Points (NAPs)
- Brazil and Argentina are the most developed in the region.
- Brazil has the highest number of IXPs with 9 run by PTT metro a non-profit organization supported by the CGI
- Policy and regulations vary from one country to another for instance Chile requires each IP operator connect to a NAP
- Regional connectivity for the region happens mostly in Miami, USA following historical reasons
- The Caribbean Islands of Haiti and Netherlands Antilles have IXPs.

Summary of European IXP

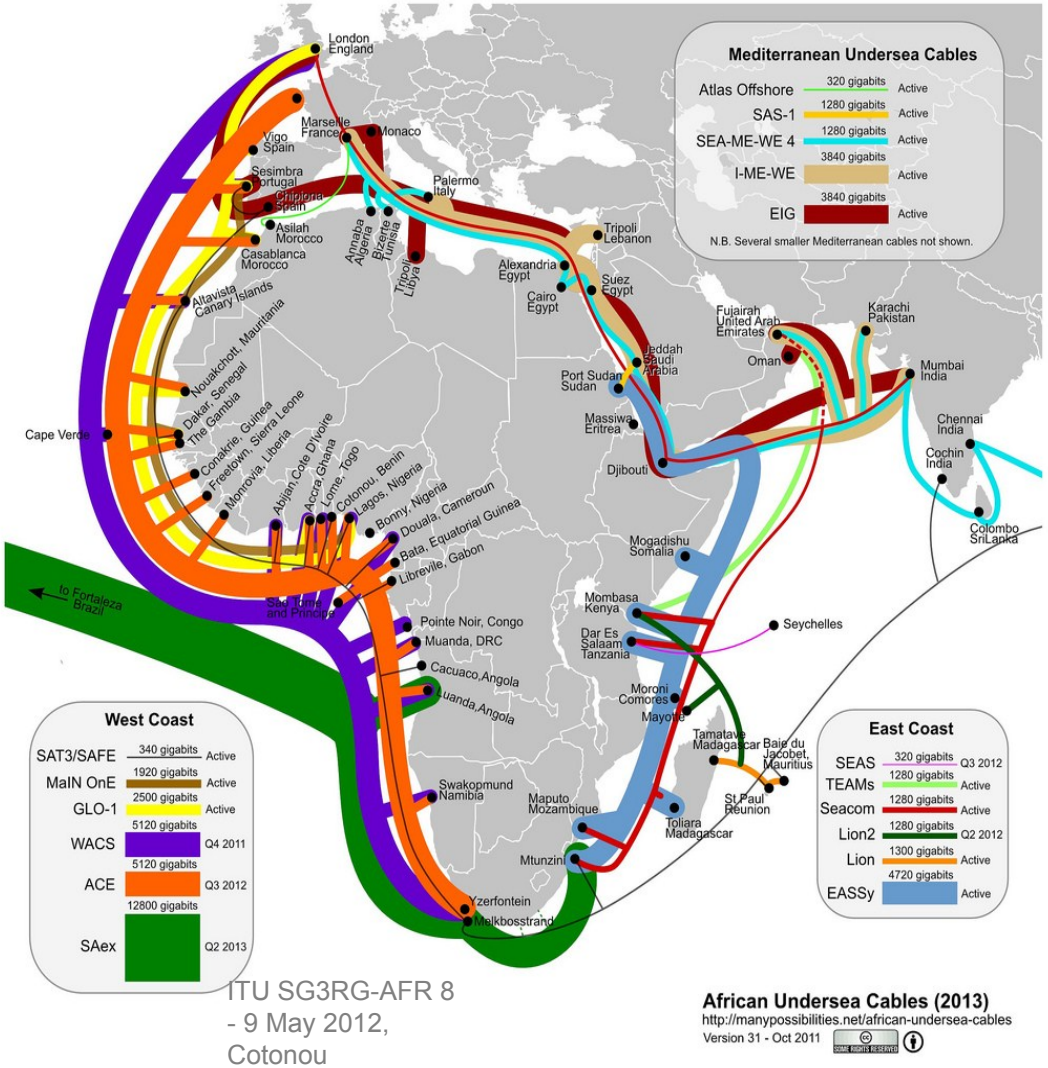
- In early stages, many Internet connections in Europe were initiated by academic, research and telcos
- In early stages of IXPs in Europe there was less competition between ISPs because Telco's kept prices of terrestrial transport and transatlantic very high.
- In early 1990's the ISPs were forced to work together to reduce cost of transporting traffic to North America – where most content was hosted
- First IXP in Europe were established in 1993 and others following in subsequent years.
- The European IXPs were established by ISP associations. The associations have since evolved and at least 65% of IXPs in Europe are ***neutral*** and ***non-profit organizations***
- Presently there are **138 IXPs in 35** Countries in Europe representing 80% of the region.
- More than 902 networks connect to more than 2 IXPs and more than 36 networks connect to more than 10 IXPs providing diverse interconnection.

Summary of Asia-Pacific IXP

- Theirs is a large difference in the countries within Asia on the level of Internet access and connectivity.
- First free IXP in Asia was Hong Kong Internet Exchange (HKIX) administered by the Chinese University of Hong Kong (CUHK).
- IXPs in Asia have been formed through various models but largely remain non-profit entities either through academia or ISP association.
- Most of the large IXPs in Asia are located along the major cable landing points such as Hong Kong, Singapore, Tokyo and Seoul
- Unique Language is one of the key factors that has driven growth of traffic in the Asian-Pacific region.
- Presently there 20 Countries with IXPs out of the 58 countries under the APNIC region representing 34%.
- Policies and regulation vary from one country to another for instance Malaysia requires operators to connect to IXPs.

Overview of Africa's Interconnection Infrastructure

Africa Submarine Infrastructure Status



- Submarine cables reach 4.4% of Africa's population
- 25.8Tbps of Submarine Cable by 2012.
- Overall International capacity went past 520Gbps (sub-sahara went past 208Gbps) in 2010 a 78% Increase from 2009.

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Africa Terrestrial Infrastructure

- 138 Route-Kms of new fiber networks Enters Service every day
- By Jan 2011, fixed line and alternative operators had over 676,739-kms of terrestrial transmission a 15% increase from previous year.
- Terrestrial infrastructure reaches close to 54 Million close to a Fiber node in Sub-Sahara Africa.

Internet exchange Points in Africa

- 26 IXPs in Africa of which only 20 are known to be operational
- 21 African Countries (39%)
- South Africa (3), Tanzania (2), Nigeria and Kenya (2) are countries with more than 1 IXP
- West Africa has lowest number of IXPs by ratio (30%).
- New IXPs launched in Lesotho and Sudan in 2011

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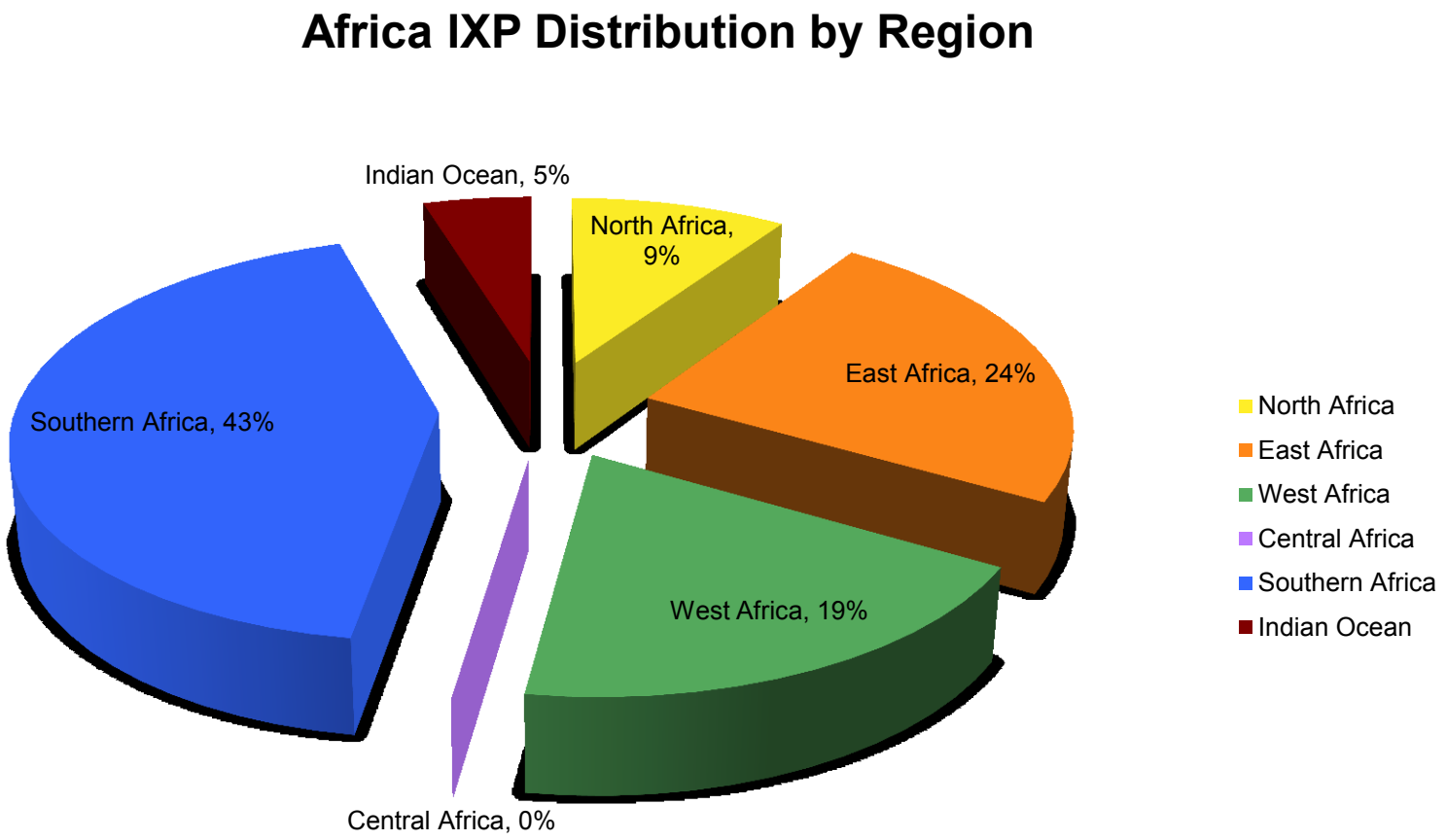
Operational IXP distribution by Region



Region	Country	City	Internet Exchange Name	Participants	Traffic	Prefixes	Established	URL
Africa (21)	Angola	Luanda	Angola Internet Exchange	10	13M		17 Mar 2006	
		Luanda	Ponto de Intercambio Internet Angola					
	Botswana	Gaborone	Botswana Internet Exchange	10			Oct 2005	
	Burundi	Bujumbura	Burundi Internet Exchange Point					
	Congo-Kinshasa	Kinshasa	Kinshasa Internet Exchange	7			Nov 2002	
	Cote D'Ivoire	Abidjan	Côte d'Ivoire Internet eXchange Point	5	4M		2006	
	Egypt (2)	Cairo	Cairo Internet Exchange	8	302M		May 2002	
		Cairo	Middle East Internet eXchange	7			May 2007	
		Cairo	Cairo Regional Internet Exchange				May 2002	
	Ghana	Accra	Ghana Internet Exchange	24			18 Oct 2005	
	Kenya	Nairobi	Kenya Internet Exchange Point	34	911M		Feb 2001	
		Mombasa	KIXP-Mombasa					
	Lesotho	Maseru	Lesotho Internet Exchange					
	Malawi	Blantyre	Malawi IXP	36			1 Dec 2008	
	Mauritius	Port Louis	Mauritius Internet Exchange	6			Dec 2005	
	Mozambique	Maputo	Mozambique Internet Exchange	16	5M		Jul 2002	
	Nigeria	Lagos	Internet eXchange Point of Nigeria	18			May 2007	
		Ibadan	Ibadan Internet Exchange				Mar 2002	
	Rwanda	Kigali	Rwanda Internet exchange					
	South Africa (3)	Cape Town	Cape Town Internet Exchange	148	1.5G		1996	
		Grahamstown	Grahamstown Internet Exchange	6	4.3M	30	13 Mar 2005	
		Johannesburg	Johannesburg Internet Exchange	47	3.3G		6 Jun 1996	
		Cape Town	Hub					
		Cape Town	NAPAfrica Cape Town					
		Johannesburg	NAPAfrica Johannesburg					
		Johannesburg	South African Internet Exchange					
	Sudan	Khartoum	Sudan Internet Exchange Point					
	Swaziland	Mbabane	Swaziland Internet Exchange	3	128K		Jun 2004	
	Tanzania (2)	Arusha	Arusha Internet Exchange Point	6	400K		26 Jun 2006	
		Dar es Salaam	Tanzania Internet Exchange	25	6.37M		Jul 2003	
	Uganda	Kampala	Uganda Internet Exchange	5	24M		Jul 2003	
	Zambia	Lusaka	Zambia Internet Exchange Point	9			Feb 2006	
	Zimbabwe	Harare	Zimbabwe Internet Exchange	5			Jul 2001	

The Regional Interconnection Challenge

Despite the growth in regional submarine, terrestrial cables and Internet Exchange Points; Routing policies continue to follow the satellite topology

For instance traffic from Rwanda a landlocked country in East Africa to Nairobi, Kenya goes via London despite the fact that the Submarine cable transit points are in Port city of Mombasa in Kenya

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Reported Interconnection Capacity Costs

South Africa

	STM-1/pm	STM-4/pm
JHB-CPT	~$32,815	~$82,037
JHB-LON	~$31,553	~$78,882

Kenya

	STM-1/pm	STM-4/pm
NBO-MSA	~$3,100	~$11,196
NBO-LON	~$23,250	~$74,640

South Africa
Local STM-4/pm = $131/Mbps
International STM-4/pm = $126/Mbps

Kenya
Local STM-4/pm = $18/Mbps
International STM-4/pm = $120/Mbps

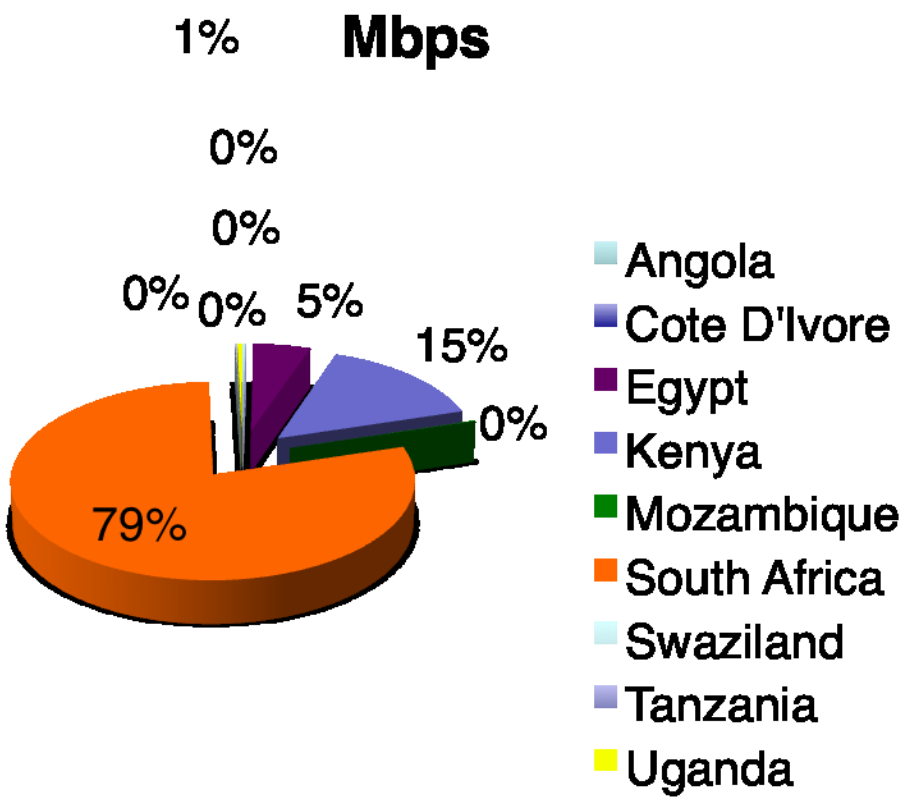
Regional/Cross-Border Costs < STM-1/pm
DAR-NBO = $183/Mbps
KPL-NBO = $75/Mbps
JHB-NBO = $110/Mbps

Content Hosting & Infrastructure

- Africa has an estimated 84,000 square meters of raised floor data center capacity or 39% of London's capacity is 215,000 square meters (by end 2011)
- South Africa remains the most developed data market
- Content flight due to lack of competitive hosting solutions
- Building Carrier Neutral Datacenters is important to enhance the reliability of hosting services
- Most of the hosting infrastructure available are in ISP data-centers and is not well developed.
- Mains power supply and reliability is the major challenge to large data center development

Observations

- Based on International traffic capacity (520Gb) and aggregate traffic measu across African IXPs (5.19Gb) its safe say that only 1% of Africa traffic is loc
- 99% of the content consumed by the over 118M Internet Users in Africa is hosted outside the region.
- 3 Countries South Africa, Kenya and Egypt contribute to the majority of the traffic
- The different cable models affect the pricing
- Observed cost savings on terrestrial circuits measured against the conten available locally moots national, regic & cross-border Interconnection optio

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Advancing the Value and Viability of IXPs in Africa

- *26 IXPs in Africa*
- *Not all at the same level of development!*
- *Most current IXPs only between "Level 1 and 2"*
- *We aim to move African IXPs "Up the Curve!"*

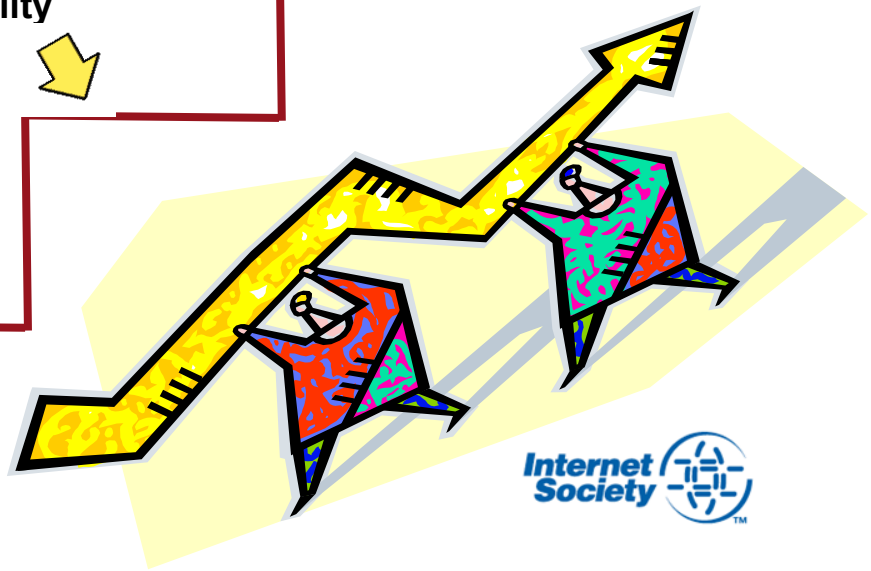
Level 4
Thriving, Critical Infrastructure

Level 3
Catalysing Growth

Level 2
Core Functionality

Level 1
"Boxes and Wires"

Level "0"
No IXP



1. Building New IXPs: 61% of Africa lacks IXPs

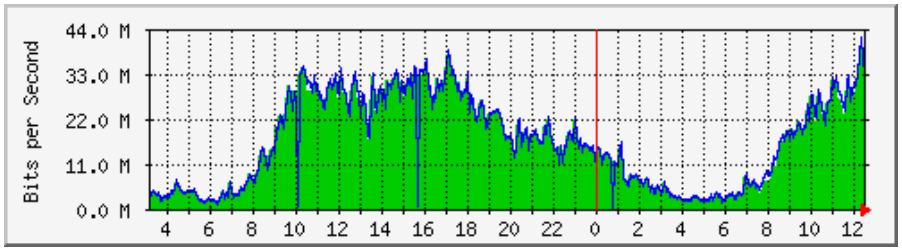
- The cost of building national IXPs is low for instance;
  - The Lesotho Internet Exchange Point was established on 26th August 2011
  - The Lesotho Communications Authority spearheaded the setup of the IXP and spent a total of R50,000 (~$4,500) for;
    - IXP Room Air conditioning
    - IXP Room burglar proofing
    - Meeting expenses during the technical training and stakeholder meetings
  - The IXP is hosted at the National University of Lesotho in a room donated by the University
  - The equipment rack was donated by the Ministry of Communications
  - The IXP Switches and Routers were donated by Internet Society in partnership with Cisco Systems.
  - IP Address space and Autonomous System Number are free from AfriNIC under the Critical Infrastructure Policy
- Therefore the cost of setting up an IXP is significantly low due to readily available support and partnership from Internet organizations.
- Estimated costs are less about ~$10,000

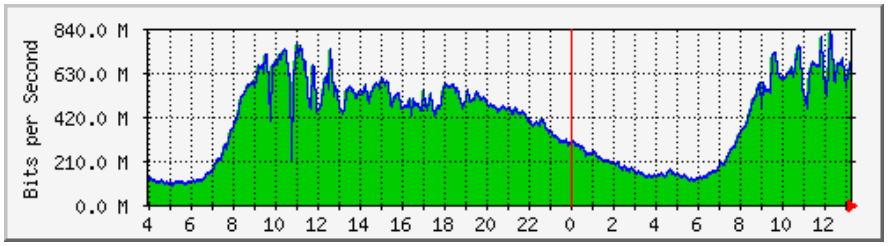
2. Enhance Value and Grow Critical Mass: 3 countries contribute to 99% of Africa's total local traffic.

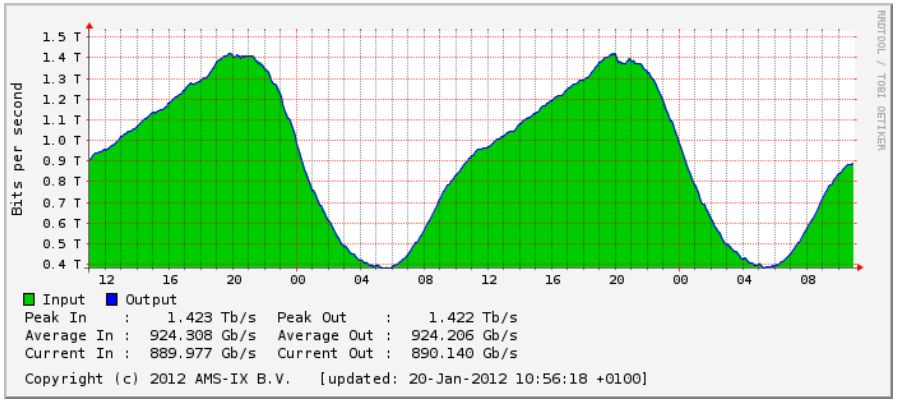
Enhancing Value of IXPs:

- Opening an IXP beyond the traditional ISP Members
  - NRENs
  - E-Government Services such as Customs, immigration, etc should
- Competition on last-mile, national and cross-border terrestrial services for high speed/fiber optic links
- Leveraging eyeball networks, infrastructure providers and content providers
  - Installation of Content providers Caching servers
  - Build Carrier Neutral Datacenters
- DNS Services such as Root-Server instances and national ccTLD

Where would you prefer to Peer?







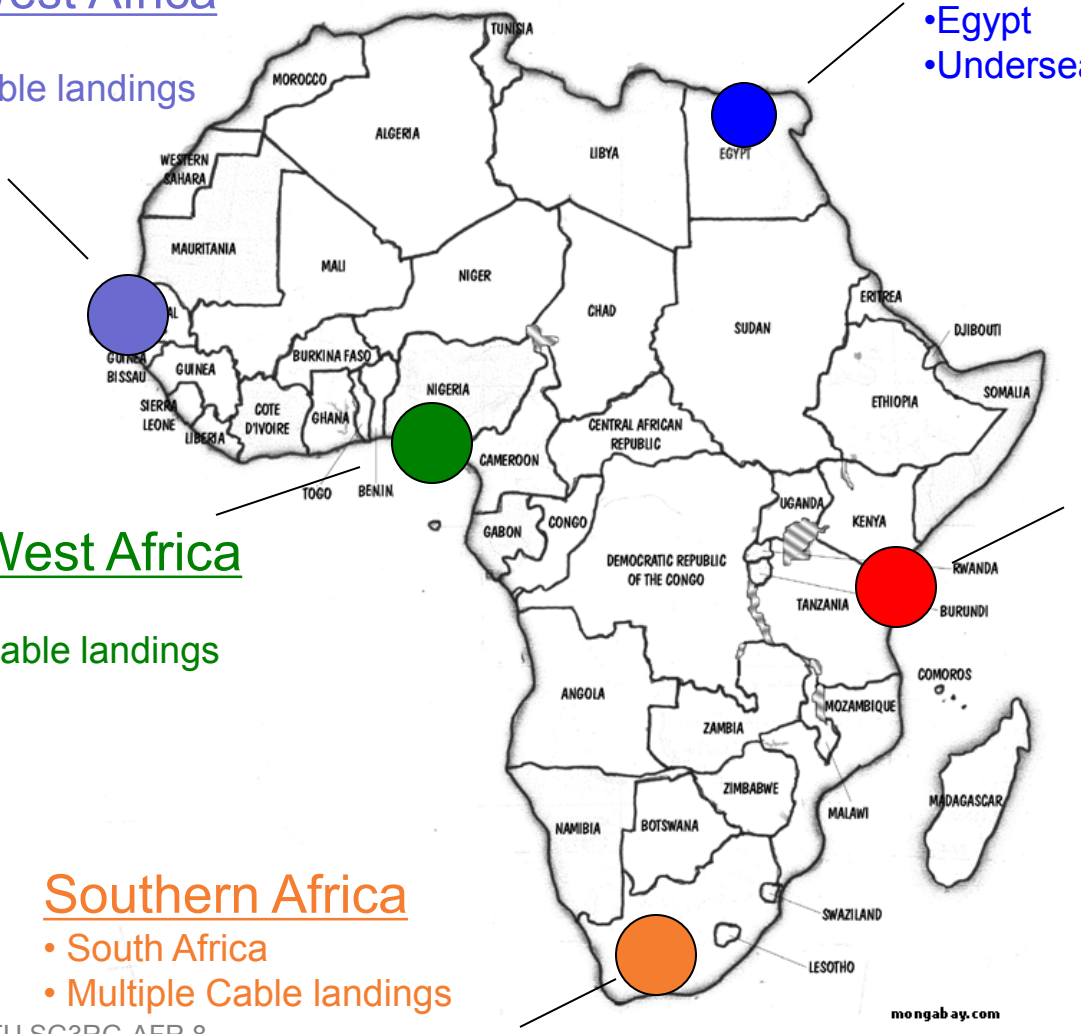
3. Communities of Practice

- Communities of practice provide a platform where stakeholders can meet and share experiences and best practices.
- In Africa such forums have had resounding success on the technical capacity building front and policy development such as AfNOG, AfriNIC, etc.
- The Africa Peering and Interconnection Forum (AfPIF) is an open forum that is aspiring to contribute to the growth of national and cross-border interconnection.
- AfPIF also helps bridge the information asymmetry on Interconnection economics for the benefit of Regulators, Governments, Operators, Research and Education Networks amongst others.
- The forum further offers opportunities to exchange ideas and learn more about the global trends on interconnection.
- More information is available www.afpif.org

4. Build Regional Interconnection & Transit "Hot Spots"

Franco-West Africa
- Senegal
- Multiple Cable landings

North-Africa (Egypt)
- Egypt
- Undersea Cable Crossroads



East Africa
- Kenya
- Multiple Cable Landings

Anglo-West Africa
- Nigeria
- Mulitple cable landings

Southern Africa
- South Africa
- Multiple Cable landings

By evolving National IXPs into Regional Peering and Global Transit points.

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5. Local Content & Hosting Incentives

- There is an absence of relevant content in the region. The following areas need further development to grow content and local hosting services.
  - E-Government Services are lacking and where available are hosted overseas. In comparison Brazil hosts 93% of the Government websites locally all reachable in under 100ms.
    - What are the statistics for African Govt websites?
  - ccTLD: - there is a correlation between local domain names and local content. South Africa has 800,000 domains under .ZA and Kenya has 20,000 domains under .KE and reflected by IXP traffic.
  - Policies: - The absence of policies and frameworks that support e-transactions and offers incentives for local hosting.


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The Kenya Internet Exchange Point (KIXP)

- The KIXP was established in 2002.
- It is operated by the ISP association TESPOK a not-for-profit entity
- Has 30 members connected to the facility and drawn from the ISP, Mobile operators, ccTLD, NREN, Government and Content providers;
- KIXP has 2 peering locations in Nairobi and 1 location in Mombasa
- KIXP is self-sustaining with members paying a monthly access based on their subscribed switch port speed i.e 10Mbps, 100Mbps or 1Gbps.
- There are over 107 Autonomous System Numbers (ASN's) visible at KIXP with over 50% of them being external to Kenya therefore increasingly acting as a regional hub for traffic from neighboring countries.

Summary Benefits of KIXP

Benefit	Without KIXP	With KIXP	Summary
Latency	200-600 ms	2-10 ms	Significant increase in performance
Local traffic exchange	Negligible	1Gbit/s peak	Estimated total saving of $1,440,000 per year on international transit
Content	All content was accessed through international links, almost all content hosted abroad	Google network present locally. Expansion and rehoming of content hosted abroad	Increased revenues up to $6 million per 100 Mbit/s of new mobile data traffic
E-government	KRA collected taxes manually	Revenues collected online	Significant reliance on KIXP to clear customs and raise revenues
Domain names	.com was the predominant domain, registered overseas	.ke is the predominant domain, registered and based locally	KENIC uses KIXP to help increase service delivery for .ke
Regional routes	All regional traffic tromboned internationally	An increasing amount of regional traffic exchanged at KIXP	KIXP more attractive to content providers and backbones able to access regional users

The Internet Exchange Point of Nigeria (IXPN)

- The IXPN was established in 2006 Lagos as a neutral exchange
- IXPN is a not-for-profit organization and was established through a public private partnership process.
- There are over 30 members connected at IXPN
- Diverse membership like Kenya with ISPs, academia, ccTLD, mobile operators and others.
- A new pop has been launched in Abuja and aiming for all 6 geopolitical zones in Nigeria
- The IXPN is self-sustaining with a business model that charges for connection similar to that of Kenya

Summary benefits of IXPN

Benefit	Without IXPN	With IXPN	Summary
Latency	200-400 ms	2-10 ms	Significant increase in performance
Local traffic exchange	Negligible	300Mbit/s peak	Estimated total saving of $1,080,000 per year on international transit
Content	All content was accessed through international links, almost all content hosted abroad	Google network present locally. Expansion and rehoming of content hosted abroad	Increased revenues of new mobile data traffic
E-government	Congestion of education & research networks	Eko-Konnect, WAEC connected to IXPN for local traffic exchange	Improved access for students and researchers
E-commerce	No service platforms hosted locally	Financial platforms hosted locally and traffic routed locally	IXPN allowed financial transactions to remains local

Summary of empirical Study of KIXP and IXPN

Benefit	KIXP	IXPN	Summary
Latency	Reduced from 200-600 ms to 2-10 ms	Reduced from 200-400 ms to 2-10 ms	Noticeable increase in performance for end users
Local traffic exchange	1 Gbit/s peak	300 Mbit/s peak	Savings on international transit of over $1 million per year in each country
Content	Google network present locally, along with rehoming of domestic content	Same as in Kenya	Increase in usage and corresponding revenues for mobile data traffic
E-government	Kenya Revenue Authority gathers taxes online	Usage by education and research networks	Social benefits from e-government access to IXPs
Other benefits	An increasing amount of regional traffic exchanged at KIXP	Financial platforms hosted locally	Further economic benefits resulting from IXPs


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Internet traffic vision for Africa: 70% local and 30% International

- The long term objective for Africa should be aim to address the Internet transit deficit from the current 99% International and 1% local to 30% International and 70% local by 2020.
- The more traffic and content accessible via IXPs the higher the value of peering in the region will be.
- The regional capacity costs will have to be revised by the various carriers and operators to be more attractive for regional interconnection and peering
- Operational IXPs need to provide statistical data to measure growth of peering and interconnection in the region.

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